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Abstract

This article illustrates how the industrial organization of a banking system affects economic growth in a partially dollarized economy. I study a model where banking competition has some potentially good and some potentially bad effects for growth. I analyze how important they are quatitatively and, surprisingly, they do not seem to matter much. The main reason for this is that while competition leads banks to offer consumers a "better deal" on their deposits, this does not lead to a large increase in the savings rate. The effect depends on the main structural parameter values of the economy. In particular, if there is a high demand for liquidity insurance. I calibrate the model for the Bolivian economy and show that the growth rates under both systems are not significantly different.

Keywords: General equilibrium and growth, Dollarization, Banking, Industrial Organization.

JEL classification: D50, F31, G21, L10.

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1 Introduction

Recent literature on dollarization has focused on the characteristics of partially dollarized economies, where dollars and local currency each account for much of the economic transactions. At the moment, much of this literature has identified the dollarization level of the banking system as being a particularly important variable to analyze the efficiency of monetary policy.[1] But, little attention has been given to the effects of the banking system structure on growth in this type of economies.

This paper tries to fill this gap, analyzing jointly the themes of banking structure, growth and dollarization. I set up a model where the effects of the industrial organization of the banking system can be studied in a systematic way. It is an overlapping generations model where banks can hold reserves in local and foreign money and, a priori, it is not clear whether competition or monopoly would be better for growth. Both systems have advantages and disadvantages. Then, I calibrate the model and show that, quantitatively, the industrial organization of the banking system does not matter much for growth, since the differences between both systems are negligible.

The works that most relate to this theme are Boyd, De Nicoló and Smith, [5] and [6], who analyze crises in competitive versus monopolistic banking systems in the first paper and discount window policy in the second one. Antinolfi *et.al.*[2] is the only reference where the dollarization of a banking system has been studied in a model with multiple currencies in a spatial-separation-and-limited-communication framework. This framework is also used in this paper, but here, to analyze growth. The model actually used, closely resembles the models of Champ, Smith, and Williamson [9], Antinolfi, Huybens and Keister [3], Bhattacharya, Haslag and Rusell [4], Haslag and Martin [15], Schreft and Smith [23] and Smith [24].

The theoretical model I use is based on Paal, Smith and Wang [20], but modified to analyze growth in partially dollarized economies. I show that higher growth rates can be reached in either system depending on the specific values that the economy presents, particularly the values for the probability of a liquidity shock and the risk aversion coefficient. When these values are high, it means that people are demanding more liquidity insurance, therefore banks will hold more reserves and less investment. Since profits for the monopolistic bank come from investment, this bank has the incentive to invest more than the competitive banks, so growth will be higher under monopoly.

The difficulty of extracting a definite conclusion arises in the monopolistic case, where growth rate could be positively or negatively related to the nominal interest rate or inflation. In the competitive system there is no doubt that growth is positively related to inflation. This is the "Mundell-Tobin" effect. It runs counter to the standard intuition, although there is some evidence that higher inflation does lead to higher growth rates in situations where the initial

[1] See, for instance, De Nicoló, *et al.*[11] who study the benefits and risks associated with a dollarized banking system and Castro, *et al.* [8] who analyze the financial vulnerability of partially dollarized economies.

inflation rate is low.[2]

The key results are presented and proved as propositions and those that turn out very complicated to prove, as in the monopolistic case, are shown numerically. Some patterns can be extracted from the numerical simulations. First, growth will be very sensitive to the coefficient of risk aversion Arrow-Pratt and the probability of liquidity demand; while growth is not very sensitive to the proportion of this demand as related to either local or foreign currency, especially if gross nominal interest rates are low. Second, for most parameterizations, growth will be higher under a competitive banking system, except when the values of the risk aversion coefficient or the probability of liquidity shock are high.

I show that the rate of growth of the economy can be divided in two effects: a "savings rate" effect and an "investment allocation" effect. The Mundell-Tobin effect appears, when the "investment allocation" effect is higher than the "savings rate" effect.

The "savings rate" effect acts through the ability of banks to provide insurance to depositors and it is negatively related to inflation. The reason is simple, when inflation (nominal interest rate) increases, it distorts the ability of banks to provide insurance, and thus banks offer a less attractive return schedule to depositors, so they save less. The "investment allocation" effect acts through an interaction between two other effects: the "peso" and the "dollar" effects. When inflation increases, banks hold fewer reserves in domestic money, in fact they substitute domestic currency with foreign currency, but this is not a one-to-one relation, the reductions in local money are higher than the increases in foreign money and so they also increase investments. In the model there are three assets: investment and currencies. We can talk about an asset substitution where the peso effect dominates the dollar effect and also promotes capital accumulation.

The contribution of this paper to the dollarization debate is that the industrial organization of the banking system does not affect dollarization at all. It is proved that the level of dollarization is exactly the same under both structures and depends primarily on inflation and the proportion of people who demand local or foreign currency.

I calibrate the model for the Bolivian economy, using yearly data, to check how large or small the differences in growth rates can be between the two systems. In a similar exercise for U.S. and Japan, Paal, et.el.[20] show that these differences could be either significant or negligible and are country specific. For the Bolivian economy in almost all the cases the economy reaches the same rate of growth under both systems with extremely small differences. I conclude that the differences appear unlikely to be important in practice.

I perform sensitivity analysis to see the effects of changing parameters one at a time ceteris paribus, the others staying fixed. Two main lessons can be extracted from these exercises: First, de-dollarizing the economy or in other words

[2] Bullard and Keating [7] showed that a permanent increase in inflation actually has a positive effect on growth rates in countries where the initial inflation rate was very low, as the Mundell-Tobin effect would predict.

having a fewer demand for liquidity in dollars, increases the growth rate but in a very small magnitude. In fact the growth range between full dollarization and no dollarization is less than one percent. Second, real rates of growth are very sensitive to the liquidity demand and the relative risk aversion coefficient. Growth is negatively related to these parameters and small variations of them are associated with huge variations in the rates of growth under both systems. Welfare is higher under the monopolistic banking system for values of β (weight given to future generations) higher than 0.8.

The remainder of the paper proceeds as follows. Section 2 describes the general environment to be used. In section 3, the three types of structures for asset trading are presented: no intermediation, competitive banks and a monopolistic bank. In section 4, I compare the real rates of growth with competitive versus monopolistic banking systems in a general equilibrium framework. Section 5 undertakes the welfare analysis, section 6 is the empirical section devoted to the numerical simulations for the Bolivian economy and in section 7 the main conclusions are reported.

2 The Environment

This is an overlapping generations model (OLG), where agents live for two periods. The economy consists of two identical locations (islands) where a continuum of agents with unit mass is born in each period. There are three types of agents: depositors, firms and banks

The distinguishing characteristic of this economy is that there are two currencies in circulation, pesos and dollars, the former of which is issued by the Central Bank and denoted by M_t. I assume the nominal local money stock grows at a rate σ set exogenously. Thus $M_{t+1} = \sigma M_t$, with $M_{-1} > 0$ given as an initial condition. An initial old generation with unit mass owns M_{-1} and also the initial capital stock k_0. Dollars can be bought and sold on an international market at the beginning of each period and the price level in dollars is always equal to 1 ($p_t^* = 1$). The domestic price level p_t is determined in the market that meets at the beginning of the period.

Both currencies share the role of store of value, but they also share a transactions role which is generated by the random relocation of people between the two spatially separated islands (see Townsend [25]). This setup allows money to be dominated in rate of return by other assets. In addition to the two domestic islands, there is an "outside" or "foreign" island that represents the rest of the world. A fraction π of young depositors in each of the domestic islands is notified that they will be moved to either the other domestic island or the foreign one.[3] From this probability of becoming a mover, a fraction θ will move to the domestic island and will need pesos, and a fraction $1-\theta$ will move to the foreign island and will need dollars. In this way a demand for both dollars and domestic currency is generated.

[3] Some people from the foreign island are also sent to the domestic islands each period, so that the number of people on each island is unchanged.

2.1 Depositors

Depositors, are identical ex ante but not ex post when they become movers and non-movers. When young, they supply labor inelastically and it is their unique endownment.

Let c_{1t} and c_{2t}^j denote the first and second period consumption of a young depositor. Here the superscript j stands for agent type; $j = m$ for movers in pesos, $j = f$ for movers in dollars and $j = n$ for "non-movers". A depositor has the lifetime expected utility:

$$u(c_{1t}, c_{2t}) = \psi \left[\frac{c_{1t}^{1-\rho}}{1-\rho}\right] + \left\{\pi \left[\theta \frac{(c_{2t}^m)^{1-\rho}}{1-\rho} + (1-\theta)\frac{(c_{2t}^f)^{1-\rho}}{1-\rho}\right] + (1-\pi)\frac{(c_{2t}^n)^{1-\rho}}{1-\rho}\right\} \tag{1}$$

where ρ is the intertemporal rate of substitution. I assume $\rho \in (0,1)$, this means that I will concentrate in economies with small income effects. Working with $\rho > 1$ (large income effects), will have counterintuitive consequences. In particular, reserve-holdings by banks will be increasing with the nominal interest rate (the opportunity cost of holding reserves). This is not the empirically plausible case (Shreft and Smith [23]).

2.2 Firms

Firms do not play a big role as economic agents, in particular, they make zero profits, because there is perfect competition. They just produce the single good at each date, using capital and labor as inputs. Consider a production function of the following form:

$$F(K_t, L_t, \overline{k}_t) = AK_t^{\alpha} L_t^{1-\alpha} \overline{k}_t^{1-\alpha} \tag{2}$$

with $\alpha \in (0,1)$, L_t is labor input, K_t denotes the capital input and $\overline{k}_t$ is the aggregate capital-labor ratio.[4] Each individual producer takes $\overline{k}_t$ as given. This externality is what allows constant returns to scale, necessary to sustain long-run, endogenous growth. In this model there is no attempt to "fix" this externality.[5]

As factor markets are competitive, both factors are paid their marginal products. Let w_t denote the real wage and r_t the rental rate of capital. Then:

$$r_t = F_1(K_t, L_t, \overline{k}_t) = \alpha A \tag{3}$$

$$w_t = F_2(K_t, L_t, \overline{k}_t) = (1-\alpha)Ak_t \equiv w(k_t) \tag{4}$$

where we use the fact that in equilibrium $k_t = \overline{k}_t$.

[4] See Romer [22].

[5] The economy might have a better outcome in equilibrium if the government were taxing somebody and paying a subsidy on capital to encourage more investment.

The gross real rate of return on capital investments between t and $t+1$ will be given by:

$$R_t = \alpha A \equiv R \tag{5}$$

Notice that with this assumption, the production function is a standard Ak production function. I am using an endogenous growth model because I want to look at how banking structure potentially affects long-run growth rates. For simplicity I assume that there is complete depreciation.

2.3 Banks

The other last type of agents are the potential bank operators. There are N of these which constitute a competitive banking system, while $N = 1$ constitutes a monopolistic banking system. Bankers care only about second period consumption, and are risk neutral. With intermediation, banks own the capital and therefore, the depositors are the indirect owners. In the next section I explain in detail this issue.

The timing of events is as follows: At the beginning of each period t, a new generation of agents is born. Firms rent capital and labor, produce goods, and pay their factors of production. Final goods are then either consumed or invested to create next period's capital stock. In particular, young depositors choose how much to save (allocate portfolios). This savings may or may not be intermediated. If they prefer the market, they invest in primary assets, if they prefer banks they make deposits and banks invest in primary assets. These primary assets are pesos, dollars and capital.

At this point, agents cannot move between or communicate across locations. Goods and capital can never be transported between locations. There are also risk-sharing issues, because agents do not know whether or not they will be movers (see Diamond and Dybvig [12]). Relocation shocks then are realized, and as people know where they are going to move, they convert their assets into currency, and move.

3 Financial Intermediation and Asset Trading

In this section I describe how assets are traded in the economy. This model of intermediated trade resembles that in Paal *et.al.*[20], but with the addition of the demand for dollars. Particularly there are three schemes: i) no intermediation, ii) a competitive banking system ($N > 1$) and iii) a monopolistic banking system ($N = 1$).

3.1 Unintermediated Asset Trade

At time t young depositors receive w_t and decide how much to save in capital and in money (domestic and foreign). After these portfolio allocations have ocurred, each depositor is informed if she will be moved or not. Depositors learning their types, meet in a market where relocated agents sell their capital investments to non-relocated agents for cash. Then relocation occurs.

Let $s_t = w_t - c_{1t}$ be the saving of the young depositor at t, i_t the amount of his capital investment, m_t real local money holdings and f_t real foreign money holdings. Let q_t be the price of a unit of capital in the post-relocation capital resale market. Let $i_t^{\prime j}$, $m_t^{\prime j}$ and $f_t^{\prime j}$ denote the capital and real money holdings in both currencies of a young depositor after having traded at the capital resale market.[6]

The constraints that a young agent faces can be formulated as:

$$\begin{aligned} c_{1t} &\leq w_t - s_t \\ i_t + m_t + f_t &\leq s_t \\ i_t^{\prime j} + \frac{p_t m_t^{\prime j}}{q_t} + \frac{p_t^* f_t^{\prime j}}{q_t} &\leq i_t + \frac{p_t m_t}{q_t} + \frac{p_t^* f_t}{q_t} \\ c_{2t}^m &\leq \frac{p_t m_t^{\prime m}}{p_{t+1}} \\ c_{2t}^f &\leq f_t^{\prime f} \\ c_{2t}^n &\leq i_t^{\prime n} R + \frac{p_t m_t^{\prime n}}{p_{t+1}} + f_t^{\prime n} \end{aligned} \tag{6}$$

A young agent of generation t chooses $c_{1t}, s_t, i_t, m_t, f_t, \left\{ i_t^{\prime j}, m_t^{\prime j}, f_t^{\prime j}, c_{2t}^j \right\}_{j=m,f,n}$ to maximize (2) subject to (6) and non-negativity constraints on consumption and asset holdings. Let the optimal value of each choice variable z_t be denoted by $\widetilde{z}_t$. Then equilibrium in the capital resale market requires:

$$\pi \left[\theta \widetilde{i}_t^{\prime m} + (1-\theta) \widetilde{i}_t^{\prime f} \right] + (1-\pi) \widetilde{i}_t^{\prime n} = \widetilde{i}_t$$

$$\pi \theta \widetilde{m}_t^{\prime m} + (1-\pi) \widetilde{m}_t^{\prime n} = \widetilde{m}_t$$

$$\pi (1-\theta) \widetilde{f}_t^{\prime f} + (1-\pi) \widetilde{f}_t^{\prime n} = \widetilde{f}_t$$

It is straightforward to see that if the following arbitrage argument holds:

$$q_t = p_t = p_t^* = 1 \tag{7}$$

agents' optimal choices in equilibrium are described by:

$$\widetilde{i}_t^{\prime m} = 0 \text{ and } \widetilde{f}_t^{\prime f} = 0 \implies m_t^{\prime m} = \widetilde{i}_t + \widetilde{m}_t + \widetilde{f}_t \text{ (movers in pesos)} \tag{8}$$

$$\widetilde{i}_t^{\prime m} = 0 \text{ and } \widetilde{m}_t^{\prime m} = 0 \implies f_t^{\prime m} = \widetilde{i}_t + \widetilde{m}_t + \widetilde{f}_t \text{ (movers in dollars)} \tag{9}$$

[6] Again $j = m, f, n$ signifies agents type.

$$\widetilde{m}_t'^n = 0 \text{ and } \widetilde{f}_t'^n = 0 \Longrightarrow \widetilde{i}_t'^n = \widetilde{i}_t + \widetilde{m}_t + \widetilde{f}_t \text{ (non-movers)} \tag{10}$$

$$\widetilde{i}_t = (1-\pi)\widetilde{s}_t, \ \widetilde{m}_t + \widetilde{f}_t = \pi \widetilde{s}_t \tag{11}$$

Since agents can re-optimize their portfolios after they have learned their types, they will choose an initial portfolio so as to make the maximum profit from the change in the relative price of capital in terms of cash from p_t to q_t and p_t^* to q_t, so equation (7) must hold. Note that equations (8) and (9) express the fact that after relocation shock is realized, movers convert all their assets in local and foreign money respectively, while equation (10) tells that non-movers convert their assets into capital. This way, the capital resale market will be in equilibrium if:

$$(1-\pi)(i_t + m_t + f_t) = i_t$$

implying (11).

Savings in this case will be given by:

$$\widetilde{s}_t = \frac{w_t}{1 + \psi^{\frac{1}{\rho}} \left\{ \pi \left[\theta \left(\frac{p_t}{p_{t+1}} \right)^{1-\rho} + (1-\theta)1 \right] + (1-\pi) R^{1-\rho} \right\}^{-\frac{1}{\rho}}} \tag{12}$$

With this savings, the lifetime expected utility level will be:

$$\widetilde{V} = \frac{w_t^{1-\rho}}{1-\rho} \left(\psi^{\frac{1}{\rho}} + \left\{ \pi \left[\theta \left(\frac{p_t}{p_{t+1}} \right)^{1-\rho} + (1-\theta)1 \right] + (1-\pi) R^{1-\rho} \right\}^{\frac{1}{\rho}} \right)^{\rho} \equiv V\left(\frac{p_t}{p_{t+1}}, 1, R, w_t \right) \tag{13}$$

3.2 Competitive Banking System

Now consider the case where young agents deposit their entire savings (s_t) in a bank and there are $N > 1$ banks.[7] The bank then allocates the deposits among pesos, dollars and capital. Banks behave as Nash competitors, so they take the returns on pesos, dollars and capital as given and offer a deposit return vector (d_t^m, d_t^f, d_t^n) for movers in pesos, dollars and non-movers respectively. Competition among banks for depositors then implies, that, in equilibrium, banks must choose $m_t, f_t, i_t, d_t^m, d_t^f$ and d_t^n to maximize the expected utility of a representative depositor.

Notice that old age consumption will be: $c_{2t}^j = d_t^j s_t$ for $j = \{m, f, n\}$ and agents will choose their savings level, s_t to maximize:

[7] As in Diamond and Dybvig [12], when competitive banks operate, all savings will be intermediated.

$$\psi\frac{(w_t-s_t)^{1-\rho}}{1-\rho}+\frac{s_t^{1-\rho}}{1-\rho}\left\{\pi\left[\theta\,(d_t^m)^{1-\rho}+(1-\theta)(d_t^f)^{1-\rho}\right]+(1-\pi)(d_t^n)^{1-\rho}\right\}$$

The optimal savings of a young depositor is then given by

$$s_t=\frac{w_t}{1+\psi^{\frac{1}{\rho}}\left\{\pi\left[\theta\,(d_t^m)^{1-\rho}+(1-\theta)(d_t^f)^{1-\rho}\right]+(1-\pi)(d_t^n)^{1-\rho}\right\}^{-\frac{1}{\rho}}}\equiv s(d_t^m,d_t^f,d_t^n) \tag{14}$$

With this savings level, a young depositor obtains the lifetime expected utility level

$$V=\frac{w_t^{1-\rho}}{1-\rho}\left(\psi^{\frac{1}{\rho}}+\left\{\pi\left[\theta\,(d_t^m)^{1-\rho}+(1-\theta)(d_t^f)^{1-\rho}\right]+(1-\pi)(d_t^n)^{1-\rho}\right\}^{\frac{1}{\rho}}\right)^{\rho}\equiv V\left(d_t^m,d_t^f,d_t^n,w_t\right) \tag{15}$$

as a function of the return vector received, and wage. Note that the function V is identical to the function (13).

In equilibrium banks compete against each other, so they must choose m_t,f_t,i_t,d_t^m,d_t^f and d_t^n to maximize (15) subject to the following constraints:

(i) Bank assets cannot exceed bank liabilities:

$$m_t+f_t+i_t\le s_t \qquad t\ge 0 \tag{16}$$

(ii) Payments to relocated agents must be made with currency

$$\pi\theta d_t^m s_t\le(m_t-b_t^m)\left(\frac{p_t}{p_{t+1}}\right) \qquad t\ge 0 \tag{17}$$

$$\pi(1-\theta)d_t^f s_t\le(f_t-b_t^f) \qquad t\ge 0 \tag{18}$$

(iii) Payments to non-relocated agents must be financed out of income from the bank's capital investments, plus any reserves it carries between periods.

$$(1-\pi)d_t^n s_t\le Ri_t+b_t^m\left(\frac{p_t}{p_{t+1}}\right)+b_t^f \qquad t\ge 0 \tag{19}$$

where b_t^m and b_t^f is the quantity of pesos and dollars carried between periods.

Notation 1 *Let* $I_t\equiv R\frac{p_{t+1}}{p_t}$ $\longrightarrow$*gross nominal interest rate in pesos;* $I_t^*\equiv R$ $\longrightarrow$*gross nominal interest rate in dollars;* $\gamma_t\equiv\frac{m_t}{s_t}$ $\longrightarrow$*ratio reserve-deposits in pesos and* $\gamma_t^*\equiv\frac{f_t}{s_t}$ $\longrightarrow$*ratio reserve-deposit in dollars.*[8]

[8] That is γ_t and γ_t^* is the fraction of assets a competitive bank holds in pesos and dollars respectively.

The following lemma shows the optimal level of reserves that a competitive bank will hold

Lemma 1 *If* $I_t > 1$ *then* $b_t^m = 0$ *and* $b_t^f = 0$*, so*

$$\gamma_t = \frac{\theta}{\theta + (1-\theta) R^{\frac{\rho-1}{\rho}} I_t^{\frac{1-\rho}{\rho}} + \left(\frac{1-\pi}{\pi}\right) I_t^{\frac{1-\rho}{\rho}}} \equiv \gamma\left(I_t\right) \tag{20}$$

and

$$\gamma_t^* = \frac{(1-\theta) R^{\frac{\rho-1}{\rho}} I_t^{\frac{1-\rho}{\rho}}}{\theta + (1-\theta) R^{\frac{\rho-1}{\rho}} I_t^{\frac{1-\rho}{\rho}} + \left(\frac{1-\pi}{\pi}\right) I_t^{\frac{1-\rho}{\rho}}} \equiv \gamma^*\left(I_t\right) \tag{21}$$

Proof. It is easy to show that when cash is a dominated asset ($I_t > 1$) then it is not optimal to carry reserves between periods, so $b_t^m = 0$ and $b_t^f = 0$. Then using equations (16) to (19) we have:

$$\pi\theta d_t^m s_t = m_t \frac{p_t}{p_{t+1}} \Longrightarrow \pi\theta d_t^m = \frac{m_t}{s_t}\frac{p_t}{p_{t+1}} = \gamma_t \frac{p_t}{p_{t+1}}$$

$$\pi(1-\theta) d_t^f s_t = f_t \Longrightarrow \pi(1-\theta) d_t^f = \frac{f_t}{s_t} = \gamma_t^*$$

$$(1-\pi) d_t^n s_t = R i_t = R(1-\gamma_t - \gamma_t^*)$$

Replacing in the utility function (15) and maximizing with respect to γ_t and γ_t^*, we obtain:

$$\gamma_t = \frac{1-\gamma_t^*}{1 + \left(\frac{1-\pi}{\pi}\right) I_t^{\frac{1-\rho}{\rho}}}$$

$$\gamma_t^* = \frac{1-\gamma_t}{1 + \left(\frac{1-\pi}{\pi(1-\theta)}\right) R_t^{\frac{1-\rho}{\rho}}}$$

Solving these equations we obtain (20) and (21).

This lemma implies that:

$$\begin{aligned}
d_t^m &= \frac{\gamma(I_t)}{\pi\theta}\frac{p_t}{p_{t+1}} = \gamma(I_t)\frac{R}{\pi\theta I_t} \\
d_t^f &= \frac{\gamma^*(I_t)}{\pi(1-\theta)} \\
d_t^n &= \frac{R(1-\gamma_t-\gamma_t^*)}{1-\pi} = \gamma(I_t)\frac{R I_t^{\frac{1-\rho}{\rho}}}{\pi\theta}
\end{aligned} \tag{22}$$

Next, I describe some useful properties of the functions $\gamma(I_t)$ and $\gamma^*(I_t)$

Lemma 2 $\gamma(I_t)$ *has the following properties:*

(i) $\lim_{I_t \to 1} \gamma(I_t) = \frac{\theta}{\theta + (1-\theta) R^{\frac{\rho-1}{\rho}} + \left(\frac{1-\pi}{\pi}\right)}$

(ii) $\lim_{I_t \to \infty} \gamma(I_t) = 0$

(iii) $\frac{I_t \gamma'(I_t)}{\gamma(I_t)} = \left(\frac{\rho-1}{\rho}\right) [1 - \gamma(I_t)]$

(iv) $\gamma'(I_t) < 0$

and $\gamma^*(I_t)$ *has the following properties:*

(i) $\lim_{I_t \to 1} \gamma^*(I_t) = \frac{(1-\theta) R^{\frac{\rho-1}{\rho}}}{\theta + (1-\theta) R^{\frac{\rho-1}{\rho}} + \left(\frac{1-\pi}{\pi}\right)}$

(ii) $\lim_{I_t \to \infty} \gamma^*(I_t) = \frac{(1-\theta) R^{\frac{\rho-1}{\rho}}}{(1-\theta) R^{\frac{\rho-1}{\rho}} + \left(\frac{1-\pi}{\pi}\right)}$

(iii) $\frac{I_t \gamma^{*\prime}(I_t)}{\gamma^*(I_t)} = \left(\frac{1-\rho}{\rho}\right) \gamma(I_t)$

(iv) $\gamma^{*\prime}(I_t) > 0$

It is shown that $\gamma(I_t)$ is a decreasing function of inflation while $\gamma^*(I_t)$ is an increasing function of inflation. This is a typical result in dollarized economies where, as inflation grows, people tend to escape from inflation substituting local money with foreign money.[9]

Related to dollarization we are going to define the "degree of dollarization" of the banking system by:

$$\Phi(I_t) = \frac{\gamma^*(I_t)}{\gamma(I_t) + \gamma^*(I_t)}$$

Substituting equations (20) and (21) gets:

$$\Phi(I_t) = \frac{1}{1 + (\frac{\theta}{1-\theta}) R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}}} \tag{23}$$

Proposition 1 *A higher nominal interest rate (which comes from higher inflation) makes the banking system more dollarized, i.e.* $\Phi'(I_t) > 0$

It is straightforward to prove this result by taking the derivative of (23). Remember that because R is constant in this model, looking at the effect of changing variable I, really means looking at the effect of changes in the inflation rate.

[9] In fact hyperinflation episodes have been the main reason of why countries have dollarized in the 80's.

3.3 Monopolistic Banking System

Now I consider the situation where $N = 1$. It is known that in a monopolistic banking system, the bank will be able to extract surplus from depositors, so we must consider the outside option of depositors. I assume that agents can intermediate their savings or trade in post-relocation resale markets, but they can not use both systems. I model the monopolistic bank announcing the returns $\widehat{d}_t^m$, $\widehat{d}_t^f$ and $\widehat{d}_t^n$ to which agents respond either by choosing a savings level $(\widehat{s}_t)$ and depositing it with the bank or by avoiding the bank altogether, investing in primary assets, and trading in the capital resale market.[10]

The potential good thing about monopoly here is that it leads to a higher level of investment, since all of the monopolist's profits are invested. With this assumption, I am maximizing the potential impact of this effect.[11]

I assume also that the timing of events is such that agents cannot withdraw deposits until after the post-relocation capital resale market closes. Thus agents who save in the bank cannot engage in additional asset trading. This assumption was also implicit in the analysis of competitive banks.[12]

As in the competitive situation, a bank allocates its portfolio between pesos $\widehat{m}_t$, dollars $\widehat{f}_t$ and capital investments $\widehat{\imath}_t$. There are two reserve ratios in $\widehat{\gamma}_t \equiv \frac{\widehat{m}_t}{\widehat{s}_t}$ for pesos and $\widehat{\gamma}_t^* \equiv \frac{\widehat{f}_t}{\widehat{s}_t}$ for dollars. Bank's profits can be written as:

$$\left[R(1 - \widehat{\gamma}_t - \widehat{\gamma}_t^*) - (1 - \pi)\widehat{d}_t^n\right] s(\widehat{d}_t^m, \widehat{d}_t^f, \widehat{d}_t^n) \tag{24}$$

Note that there are two terms in equation (24). The first term reflects the value of the bank's return on capital investments less payments to non-relocated agents, so it is the profit per unit deposited. The second term is total deposits, which is chosen by depositors in response to the returns offered by the bank. The bank takes the function s as given.

A monopoly bank maximizes profits subject to the participation constraint:

$$V(\widehat{d}_t^m, \widehat{d}_t^f, \widehat{d}_t^n, w_t) \geq V(\frac{p_t}{p_{t+1}}, 1, R, w_t) \tag{25}$$

This constraint says that depositors do not strictly prefer to avoid intermediation and participate directly in the post-relocation asset market. Then, maximizing (24) subject to (25) and non-negativity constraints, we obtain the optimal values of the returns offered by the bank and the reserves maintained in pesos and dollars.

[10] A monopolistic bank may be able to preclude agents from directly holding the primary assets by setting a minimum deposit requirement that is equal to agents' savings, but I do not want to allow banks to influence savings decisions this way.

[11] I could have instead assumed the monopolist does some consumption in period 1, for example.

[12] Jacklin [16] showed, when agents are allowed to trade in secondary markets after they have learned their types, the insurance provision function of banks breaks down.

Lemma 3 *When $I_t > 1$, the monopoly bank sets*

$$\widehat{\gamma}_t = \left\{ \frac{\pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho}}{\pi \left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta) \right] + (1-\pi) R^{\frac{1-\rho}{\rho}}} \right\}^{\frac{1}{1-\rho}} \pi\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} \equiv \widehat{\gamma}(I_t) \tag{26}$$

$$\widehat{\gamma}_t^* = \left\{ \frac{\pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho}}{\pi \left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta) \right] + (1-\pi) R^{\frac{1-\rho}{\rho}}} \right\}^{\frac{1}{1-\rho}} \pi(1-\theta) \equiv \widehat{\gamma}^*(I_t) \tag{27}$$

Proof. Let λ_t be the Lagrange multiplier associated with constraint (25) at t. Then the bank's first order conditions will be:

$\widehat{\gamma}_t : R = \lambda_t \pi^\rho \theta^\rho \left(\frac{p_t}{p_{t+1}}\right)^{1-\rho} \widehat{\gamma}_t^{-\rho}$

$\widehat{\gamma}_t^* : R = \lambda_t \pi^\rho (1-\theta)^\rho \widehat{\gamma}_t^{*-\rho}$

$\widehat{d}_t^n : \widehat{d}_t^n = \lambda_t^{\frac{1}{\rho}}$

From the first two FOC's we obtain:

$$\widehat{\gamma}_t = \frac{\lambda_t^{\frac{1}{\rho}} \pi\theta \left(\frac{p_t}{p_{t+1}}\right)^{\frac{1-\rho}{\rho}}}{R^{\frac{1}{\rho}}}$$

$$\widehat{\gamma}_t^* = \frac{\lambda_t^{\frac{1}{\rho}} \pi(1-\theta)}{R^{\frac{1}{\rho}}}$$

Making the respective replacements gives:

$$\lambda_t = \left\{ \frac{\pi \left[\theta \left(\frac{p_t}{p_{t+1}}\right)^{1-\rho} + (1-\theta) \right] + (1-\pi) I_t^{1-\rho} \left(\frac{p_t}{p_{t+1}}\right)^{1-\rho}}{\pi \left[\theta \left(\frac{p_t}{p_{t+1}}\right)^{\frac{1-\rho}{\rho}} + (1-\theta) \right] + (1-\pi) I_t^{\frac{1-\rho}{\rho}} \left(\frac{p_t}{p_{t+1}}\right)^{\frac{1-\rho}{\rho}}} \right\}^{\frac{\rho}{1-\rho}} I_t \frac{p_t}{p_{t+1}}$$

From these we obtain equations (26) and (27).

With this, the monopolistic bank offers:

$$\begin{aligned} \widehat{d}_t^m &= \frac{\widehat{\gamma}(I_t)}{\pi\theta} \frac{p_t}{p_{t+1}} = \widehat{\gamma}(I_t) \frac{R}{\pi\theta I_t} \\ \widehat{d}_t^f &= \widehat{\gamma}^*(I_t) \frac{1}{\pi(1-\theta)} \\ \widehat{d}_t^n &= \widehat{\gamma}(I_t) \frac{R I_t^{\frac{1-\rho}{\rho}}}{\pi\theta} \end{aligned} \tag{28}$$

Note that $\widehat{d}_t^n = \widehat{d}_t^m I_t^{\frac{1}{\rho}}$, this means that there is a "wedge" between the return received by relocated and non-relocated agents that depends on the nominal interest rate I_t. This is because, in order to insure depositors against relocation risk, banks must hold cash reserves. With positive nominal rates of interest, the holding of cash reserves involves an opportunity cost. The higher the opportunity cost, the less insurance depositors receive against the risk of relocation. This reflects the fact that the monopolist bank prices efficiently, but extracts all surplus.

The following lemma presents some useful properties of $\widehat{\gamma}(I_t)$ and $\widehat{\gamma}^*(I_t)$:

Lemma 4 $\widehat{\gamma}(I_t)$ *has the following properties:*

(i) $lim_{I_t \to 1}\widehat{\gamma}(I_t) = \left\{ \frac{\pi\left[\theta R^{1-\rho}+(1-\theta)\right]+(1-\pi)R^{1-\rho}}{\pi\left[\theta R^{\frac{1-\rho}{\rho}}+(1-\theta)\right]+(1-\pi)R^{\frac{1-\rho}{\rho}}} \right\}^{\frac{1}{1-\rho}} \pi\theta R^{\frac{1-\rho}{\rho}}$

(ii) $lim_{I_t \to \infty}\widehat{\gamma}(I_t) = 0$

(iii) $\frac{I_t\widehat{\gamma}'(I_t)}{\widehat{\gamma}(I_t)} = \left(\frac{1}{1-\rho}\right)\frac{I_t\gamma'(I_t)}{\gamma(I_t)} + 1 - \frac{\theta}{\theta+(1-\theta)R^{\rho-1}I_t^{1-\rho}+(\frac{1-\pi}{\pi})I_t^{1-\rho}}$

(iv) $\widehat{\gamma}'(I_t) < 0$

and $\widehat{\gamma}^*(I_t)$ *has the following properties:*

(i) $lim_{I_t \to 1}\widehat{\gamma}^*(I_t) = \left\{ \frac{\pi\left[\theta R^{1-\rho}+(1-\theta)\right]+(1-\pi)R^{1-\rho}}{\pi\left[\theta R^{\frac{1-\rho}{\rho}}+(1-\theta)\right]+(1-\pi)R^{\frac{1-\rho}{\rho}}} \right\}^{\frac{1}{1-\rho}} \pi(1-\theta)$

(ii) $lim_{I_t \to \infty}\widehat{\gamma}^*(I_t) = \left\{ \frac{\pi(1-\theta)+(1-\pi)R^{1-\rho}}{\pi(1-\theta)+(1-\pi)R^{\frac{1-\rho}{\rho}}} \right\}^{\frac{1}{1-\rho}} \pi(1-\theta)$

(iii) $\frac{I_t\widehat{\gamma}^{*\prime}(I_t)}{\widehat{\gamma}^*(I_t)} = \left(\frac{1}{1-\rho}\right)\frac{I_t\gamma^{*\prime}(I_t)}{\gamma^*(I_t)} - \frac{\theta}{\theta+(1-\theta)R^{\rho-1}I_t^{1-\rho}+(\frac{1-\pi}{\pi})I_t^{1-\rho}}$

(iv) $\widehat{\gamma}^{*\prime}(I_t) > 0$

The same as in the competitive case, in the monopolistic banking system $\widehat{\gamma}(I_t)$ is a decreasing function of I_t and $\widehat{\gamma}^*(I_t)$ is an increasing functions of I_t.

Defining the level of dollarization in the same way as in equation (23), it can be shown that

$$\widehat{\Phi}(I_t) = \frac{1}{1+(\frac{\theta}{1-\theta})R^{\frac{1-\rho}{\rho}}I_t^{\frac{\rho-1}{\rho}}} \tag{29}$$

The surprising thing here is that $\Phi(I_t) = \widehat{\Phi}(I_t)$. This means that the level of dollarization in banking systems is independent of its structure. Whether the system is competitive or monopolistic, the level of dollarization as defined here, will be the same. Of course this does not mean that banks will have the same dollar-reserves. So, in the rest of the paper, I will concentrate more on the growth effect.

Corollary 1 *When $R = I_t = 1$, $\gamma(I_t) = \widehat{\gamma}(I_t) = \pi\theta$ and $\gamma^*(I_t) = \widehat{\gamma}^*(I_t) = \pi(1-\theta)$.*

Proof. By substituting $R = I_t = 1$ in equations (20), (21), (26) and (27) we obtain the result.

What this corollary says is that when $R = I_t = 1$, all assets yield the same return and there is no role for financial intermediaries. The market would do just as well as a competitive bank, and therefore the monopolist must offer the same contract that a competitive bank would. This implies that the monopolist earns zero profits. The value of the banking system, and hence the power of the monopolist, comes from being able to provide insurance to agents when different assets have different returns.[13]

3.4 Level of investment in both Systems

It is well known that there is a positive and strong relation between growth and investment and in this model it is the main source of growth. Here, I will concentrate on the influence that banks could have on growth, so it is necessary to analyze how savings and investment are related to growth and how the structure of the banking system affects the economy level of investment. The level of investment under a competitive banking system is defined by $\Psi(I_t) = 1 - \gamma(I_t) - \gamma^*(I_t)$ and $\widehat{\Psi}(I_t) = 1 - \widehat{\gamma}(I_t) - \widehat{\gamma}^*(I_t)$ is the level of investment under a monopolistic banking system.

Proposition 2 *For any $I_t > 1$, $\widehat{\Psi}(I_t) > \Psi(I_t)$.*

Proof. *Replacing the corresponding expressions for reserves, we obtain:*

$$\Psi(I_t) = \frac{(1-\pi)R^{\frac{1-\rho}{\rho}}}{\pi\left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta)\right] + (1-\pi)R^{\frac{1-\rho}{\rho}}} \tag{30}$$

and

$$\widehat{\Psi}(I_t) = \frac{\begin{array}{c}\left\{\pi\left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta)\right] + (1-\pi)R^{\frac{1-\rho}{\rho}}\right\}^{\frac{1}{1-\rho}} - \\ \left\{\pi\left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta)\right] + (1-\pi)R^{1-\rho}\right\}^{\frac{1}{1-\rho}} \left[\pi\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + \pi(1-\theta)\right]\end{array}}{\pi\left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta)\right] + (1-\pi)R^{\frac{1-\rho}{\rho}}} \tag{31}$$

Doing a change of variable, let´s call:

$A(I_t) = \pi\left[\theta R^{\frac{1-\rho}{\rho}} I_t^{\frac{\rho-1}{\rho}} + (1-\theta)\right] + (1-\pi)R^{\frac{1-\rho}{\rho}}$ *and*

[13] Note also that the level of reserves that banks will hold is exactly equal to the liquidity demand in pesos and dollars.

$B(I_t) = \pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta)\right] + (1-\pi)R^{1-\rho}$ *then we can write equations (30) and (31) as:*

$$\Psi(I_t) = \frac{(1-\pi)R^{\frac{1-\rho}{\rho}}}{A(I_t)}$$

and

$$\widehat{\Psi}(I_t) = \frac{A(I_t)^{\frac{1}{1-\rho}} - B(I_t)^{\frac{1}{1-\rho}}\left[A(I_t) - (1-\pi)R^{\frac{1-\rho}{\rho}}\right]}{A(I_t)^{\frac{1}{1-\rho}}}$$

so

$$\widehat{\Psi}(I_t) = 1 - A(I_t)^{-\frac{\rho}{1-\rho}} B(I_t)^{\frac{1}{1-\rho}} + A(I_t)^{-\frac{\rho}{1-\rho}} B(I_t)^{\frac{1}{1-\rho}} \Psi(I_t)$$

It is easy to see that $\widehat{\Psi}(I_t) > \Psi(I_t)$.

The intuition is simple. The level of investment will be higher under the monopolistic banking system, because the monopolist's profits actually come from investment.

There is a positive relation between interest rates and investment. It is just the Mundell-Tobin effect again. When the nominal interest rate goes up, banks will hold less money and therefore will place more resources into investment. Note also that, with the Ak production function used here, the real interest rate stays constant no matter how much is invested.

Proposition 3 *There is a positive relation between nominal interest rates and investment. This means that* $\Psi'(I_t) > 0$ *and* $\widehat{\Psi}'(I_t) > 0$.

Proof. *As* $\rho < 1$, *it is easy to see that:*

$A'(I_t) = \left(\frac{\rho-1}{\rho}\right)\pi\theta R^{\frac{1-\rho}{\rho}} I_t^{-\frac{1}{\rho}} < 0$ *and*

$B'(I_t) = (\rho-1)\pi\theta R^{1-\rho} I_t^{\rho-2} < 0.$

With this we can see that:

$$\Psi'(I_t) = \frac{-(1-\pi)R^{\frac{1-\rho}{\rho}} A'(I_t)}{A(I_t)^2} > 0$$

and

$$\begin{aligned}\widehat{\Psi}'(I_t) &= -[1-\Psi(I_t)]\left(\frac{\rho}{1-\rho}\right)\left(\frac{B(I_t)}{A(I_t)}\right)^{\frac{\rho}{1-\rho}} A'(I_t)\left[\left(\frac{I_t}{R}\right)^{\frac{(1-\rho)^2}{\rho}} - \frac{B(I_t)}{A(I_t)}\right] \\ &\quad + A(I_t)^{-\frac{\rho}{1-\rho}} B(I_t)^{\frac{1}{1-\rho}} \Psi'(I_t)\end{aligned}$$

the term in brackets is positive and it can be written as:

$\pi(1-\theta)R^{-\frac{(1-\rho)^2}{\rho}} I_t^{\frac{(1-\rho)^2}{\rho}} + (1-\pi) I_t^{\frac{(1-\rho)^2}{\rho}} R^{1-\rho} > \pi(1-\theta) + (1-\pi)R^{1-\rho}$

so $\widehat{\Psi}'(I_t) > 0$.

Now we are ready to go one step ahead and ask the following question: Does this result mean that the growth rate will be higher under the monopolistic banking system than under the competitive one?

4 General Equilibrium and Economic Growth

In this section, I show that both systems have its advantages and disadvantages in terms of growth in a general equilibrium setting. It is easy to extract conclusions for the competitive case, but difficult to do the same for the monopolistic case.

4.1 General Equilibrium with a Competitive Banking System

I begin defining the equilibrium.

Definition 1 *An equilibrium with competitive banks can be defined as sequences of* $\{k_t\}_{t=1}^{\infty}$, $\left\{M_t, p_t, I_t, I_t^*, d_t^m, d_t^f, d_t^n\right\}_{t=0}^{\infty}$ *that satisfy the following conditions:*

(i) Money market clears:

$$\frac{M_t}{p_t} = \gamma(I_t)s(d_t^m, d_t^f, d_t^n) \tag{32}$$

(ii) The capital stock evolves according to

$$k_{t+1} = [1 - \gamma(I_t) - \gamma^*(I_t)]\, s(d_t^m, d_t^f, d_t^n) \tag{33}$$

(iii) The rate of return schedule (d_t^m, d_t^f, d_t^n) *offered to depositors is given by (22).*

(iv) The Fisher equation holds, i.e.

$$I_t = R\frac{p_{t+1}}{p_t} \tag{34}$$

(v) and also

$$I_t^* = R \tag{35}$$

It is already known that $M_{t+1} = \sigma M_t$; M_{-1} and k_0 are given, and the functions $\gamma(I_t), \gamma^*(I_t)$ and $s(d_t^m, d_t^f, d_t^n)$ are given by (20), (21) and (14).

Let's define $\eta_t \equiv \frac{s_t}{w_t}$ as the savings per young agent. The following lemma describes the properties of the savings rate:

Lemma 5 *Under a competitive banking system,*

(i) The savings rate of a young agent can be written as:.

$$\eta_t = \frac{1}{1 + \psi^{\frac{1}{\rho}} R^{\frac{\rho-1}{\rho}} I_t^{\frac{1-\rho}{\rho}} \left\{\pi\left[\theta + (1-\theta)R^{\frac{\rho-1}{\rho}} I_t^{\frac{1-\rho}{\rho}}\right] + (1-\pi)I_t^{\frac{1-\rho}{\rho}}\right\}^{-1}} \equiv \eta(I_t) \tag{36}$$

(ii) $\eta'(I_t) < 0$ *holds.*[14]

Expression (36) shows that the savings rate can simply be written as a function of the nominal interest rate, and it is a decreasing function. A higher nominal interest rate reduces savings, because it distorts the banks' ability to provide insurance to depositors against adverse liquidity shocks, and makes banks offer a less favorable real return schedule on deposits. Depositors react to this by saving less.

From the lemma it can be seen that the money market clears if:

$$\frac{M_t}{P_t} = \gamma(I_t)\eta(I_t)(1-\alpha)Ak_t \tag{37}$$

Define the gross growth rate of the capital stock (and output), μ_t as:

$$\mu_t \equiv \frac{k_{t+1}}{k_t} \tag{38}$$

From (14) and (33), we have:

$$\mu_t = \eta(I_t)\left[1-\gamma(I_t)-\gamma^*(I_t)\right](1-\alpha)A \equiv \mu(I_t) \tag{39}$$

which can also be written using the definition of the investment function $\Psi(I_t)$ as:

$$\mu(I_t) = \Psi(I_t)\eta(I_t)(1-\alpha)A$$

For this case, we can derive a nice expression for the growth rate, specifically we have:

$$\mu(I_t) = \frac{(1-\alpha)A(1-\pi)}{\pi\theta I_t^{\frac{\rho-1}{\rho}} + \pi(1-\theta)R^{\frac{\rho-1}{\rho}} + (1-\pi) + \psi^{\frac{1}{\rho}}R^{\frac{\rho-1}{\rho}}} \tag{40}$$

and

$$\mu'(I_t) = \frac{(1-\alpha)A(1-\pi)\pi\theta\left(\frac{1-\rho}{\rho}\right)I_t^{-\frac{1}{\rho}}}{\left[\pi\theta I_t^{\frac{\rho-1}{\rho}} + \pi(1-\theta)R^{\frac{\rho-1}{\rho}} + (1-\pi) + \psi^{\frac{1}{\rho}}R^{\frac{\rho-1}{\rho}}\right]^2} \tag{41}$$

From (41), it is easy to see that $\mu'(I_t) > 0$. This means that inflation is good for growth. This is a very common result in economies where the rate of inflation is relatively low. It is what is called the "Mundell-Tobin" effect and proved empirically by Bullard and Keating [7] and Kahn and Senhadji [17]. When inflation is high, the relative cost of providing consumption to domestic movers is high and therefore the bank optimally chooses to give less to them.

[14] Note that we can express $\eta(I_t)$ in terms of the auxiliary variables $A(I_t)$ and $B(I_t)$ as: $\eta(I_t) = \frac{A(I_t)}{\psi^{\frac{1}{\rho}}+A(I_t)}$ and $\eta'(I_t) = \frac{A'(I_t)\psi^{\frac{1}{\rho}}}{\left(\psi^{\frac{1}{\rho}}+A(I_t)\right)^2} < 0$.

Hence the bank holds fewer pesos (in real terms) and more investment, which leads to higher growth.

Another explanation is that while higher nominal interest rates reduce savings rates ($\eta'(I_t) < 0$), they also induce banks to economize on peso reserves "peso effect" ($\gamma'(I_t) < 0$), although not in dollars ($\gamma^{*\prime}(I_t) > 0$). The "peso effect" dominates inducing a change in bank asset portfolio composition that increases the rate of capital accumulation.

It remains to determine the equilibrium value of the nominal interest rate. Using (34) and (37) we get:

$$I_t = \frac{\sigma R}{\mu(I_t)} \frac{\gamma(I_t)\eta(I_t)}{\gamma(I_{t+1})\eta(I_{t+1})} \tag{42}$$

I will concentrate the analysis in the balanced growth path of the economy, this means that a solution must satisfy: $I_{t+1} = I_t = I$, and:

$$I\mu(I) = \sigma R \tag{43}$$

It can be seen that I is an increasing function of the money growth rate σ. The equilibrium rate of inflation is $\frac{P_{t+1}}{P_t} = \frac{I}{R} = \frac{\sigma}{\mu(I_t)}$, which is also an increasing function of σ. It is also well known that the steady state (net) inflation rate will be positive if the growth rate of money supply is larger than the growth rate of the capital stock, and negative (a deflation) if it is smaller.

4.2 General Equilibrium with a Monopolistic Banking System

First we have to derive savings in the presence of a monopoly bank, for this task we have to express the returns in terms of $\widehat{d_t^m}$, so we have $\widehat{d_t^f} = \widehat{d_t^m} I_t^{\frac{1}{\rho}} R^{-\frac{1}{\rho}}$ and $\widehat{d_t^n} = \widehat{d_t^m} I_t^{\frac{1}{\rho}}$; replacing in (14), gives:

$$\widehat{s}_t = \frac{w_t}{1 + \psi^{\frac{1}{\rho}} \left\{ \pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho} \right\}^{-\frac{1}{\rho}}} \tag{44}$$

so

$$\widehat{\eta}\left(I_t\right) = \frac{1}{1 + \psi^{\frac{1}{\rho}} \left\{ \pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho} \right\}^{-\frac{1}{\rho}}} \tag{45}$$

This is the saving rate of a young depositor born at t. It is easy to prove that $\widehat{\eta}'\left(I_t\right) < 0$, so that again higher nominal rates of interest reduce the overall savings rate.[15]

[15] In fact:
$$\widehat{\eta}'\left(I_t\right) = \frac{-\left(\frac{1-\rho}{\rho}\right) \psi^{\frac{1}{\rho}} \left\{ \pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho} \right\}^{-\frac{1}{\rho}-1} \pi \theta R^{1-\rho} I_t^{\rho-2}}{\left(1 + \psi^{\frac{1}{\rho}} \left\{ \pi \left[\theta R^{1-\rho} I_t^{\rho-1} + (1-\theta) \right] + (1-\pi) R^{1-\rho} \right\}^{-\frac{1}{\rho}}\right)^2}$$

As in the competitive case, I define a competitive equilibrium following the same steps. In this way the money market clearing condition and the capital accumulation equation are:

$$\frac{M_t}{P_t} = \widehat{\gamma}(I_t)\widehat{\eta}(I_t)(1-\alpha)Ak_t \tag{46}$$

and

$$\frac{k_{t+1}}{k_t} = \left[1 - \widehat{\gamma}(I_t) - \widehat{\gamma}^*(I_t)\right]\widehat{\eta}(I_t)(1-\alpha)A \equiv \widehat{\mu}(I_t) \tag{47}$$

or

$$\widehat{\mu}(I_t) = \widehat{\Psi}(I_t)\widehat{\eta}(I_t)(1-\alpha)A \tag{48}$$

To derive the main implications of $\widehat{\mu}(I_t)$, specifically how is $\widehat{\mu}'(I_t)$, looking at the next equation, it can be seen that this task is very difficult analytically, because the first term in brackets is positive and the second term is negative, so we need to prove which one is bigger. Looking at $\widehat{\Psi}'(I_t)$, in the proof of proposition 6, it can be seen that this is a rare and big expression.

$$\widehat{\mu}'(I_t) = (1-\alpha)A\left[\widehat{\Psi}'(I_t)\widehat{\eta}(I_t) + \widehat{\Psi}(I_t)\widehat{\eta}'(I_t)\right]$$

This is really a very difficult problem and making further progress analytically does not seem possible, so I will try to gain some additional insight by using numerical simulations. Doing this, I need to make sure that the results I report are qualitatively robust to changes in all of the parameter values. But at this time, I only want to show that the change in the growth rate for different values of the nominal interest rate, can be positive or negative depending on the parameter values chosen.

Figure 1: Interest Rate Sensitivity of Growth-Monopolistic Banking System

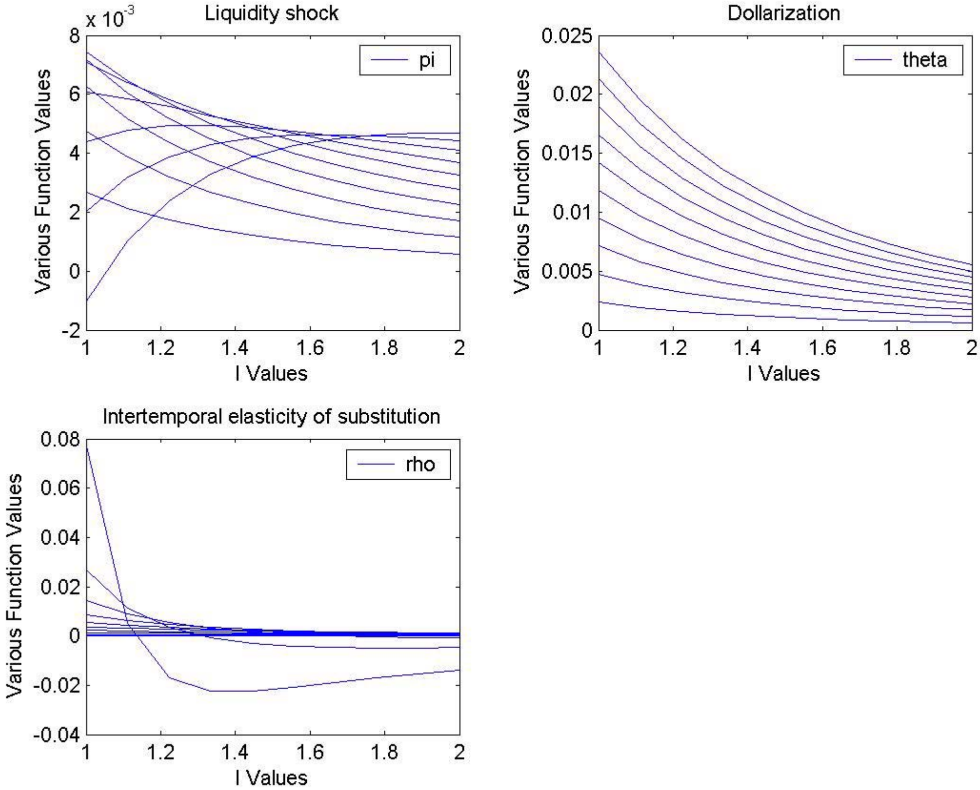


Figure 1 shows some simulations. I move one parameter at a time and I report the results for the three parameters that change between 0 and 1,which are π, ρ, and θ. The grid for the I values goes from 1 to 2, which means that we are considering nominal interest rates that go from 0 percent ($I = 1$) to 100 percent ($I = 2$).[16]

It can be seen that depending on the parameter values $\widehat{\mu}'(I_t)$ will be positive or negative, which means that the growth rate under a monopolistic banking system will be increasing for some combination of parameters and decreasing for other combination of parameters. For the dollarization parameter θ, the pattern of this function is regular and decreasing while for the other parameters it is very irregular.[17]

For this specific parameterization, changes in the risk aversion coefficient ρ appear to affect more $\widehat{\mu}'(I_t)$ for low values of I, and in particular when ρ is far away from 1. In the figure $\rho = 0.1$ corresponds to the function that starts at

[16] I assume: $A = 1$, $\alpha = 1/3$, $R = 1.05$ and $\psi = 1$.

[17] I call θ the dollarization parameter, but in fact $1-\theta$ represents people who demand dollars.

0.08. The changes in the dollarization parameter θ affect $\widehat{\mu}'(I_t)$ for all values of I. Recall that this is the case for this specific parameterization, for other parameterizations the sensibility can change. In any case, extensive simulations have been performed with a variety of sets of parameter values and the results are always qualitatively similar to those presented here.[18]

Certainly, if we think that in a "normal" economy the gross real rate of interest is 1.05 and let's say the gross inflation rate is 1.05 also, the gross nominal interest rate must be near 1.1. Looking at this value, $\widehat{\mu}'(I_t)$ is a decreasing function for different valueas of θ and both increasing and decreasing for different values of π and ρ, in this particular example.

Again, in a balanced growth path $I_{t+1} = I_t = I$, and satisfies:

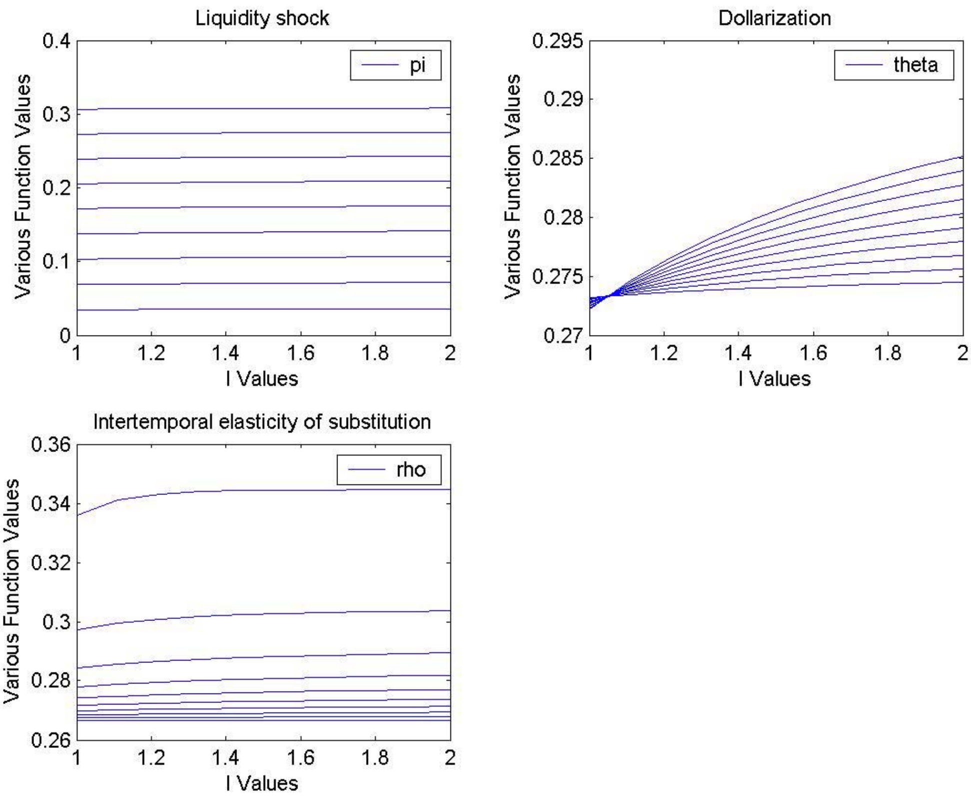
$$I\widehat{\mu}(I) = \sigma R \tag{49}$$

4.3 Equilibrium Rates of Growth under Competition vs Monopoly

Here I assume that I is the same for both types of systems and I compare the growth rates under both types of banking systems. We start by comparing the growth rates of both systems for different parameter values, one at a time.

[18]Performed simulations can be seen by request to the author.

Figure 2: Growth Rate - Competitive Banking System



First, note that for different values of the liquidity shock π the growth function is flat. It is the same for different values of the coefficient of risk aversion ρ when I is high. Only the growth functions for different values of θ show an increasing pattern. Second, as π and ρ values increase, the rate of growth of the economy decrease; while as θ increases, the rate of growth also increases.

In this section, I am only interested to see how the growth rate changes with different values for the structural parameters of this economy. Nothing can be said about magnitudes. The results presented here are only saying that small changes in the parameters will be associated with big changes in the rate of growth, in particular for parameters π and ρ.

A theoretical result, said that the Mundell Tobin effect is present in an economy with a competitive banking system, figure 2 shows that this is true. It can also be seen that in all cases the growth rate is increasing in I. It appears also that growth reaches a constant path for interest rates higher than 20 percent, when θ is fixed.

Figure 3: Growth Rate - Monopolistic Banking System

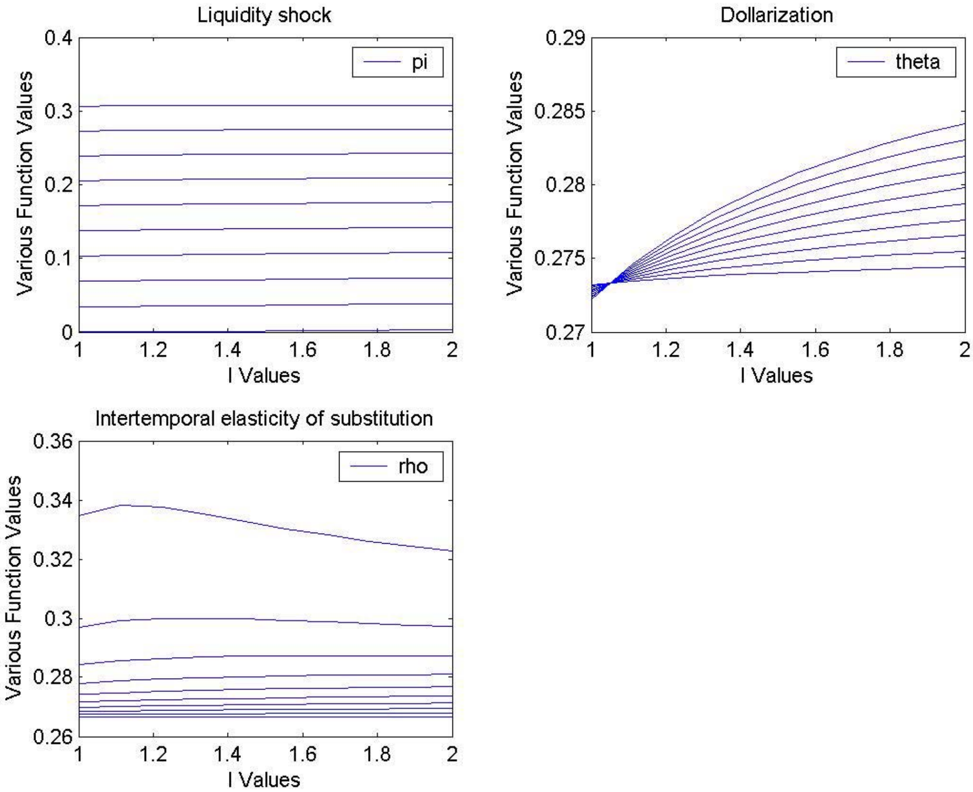
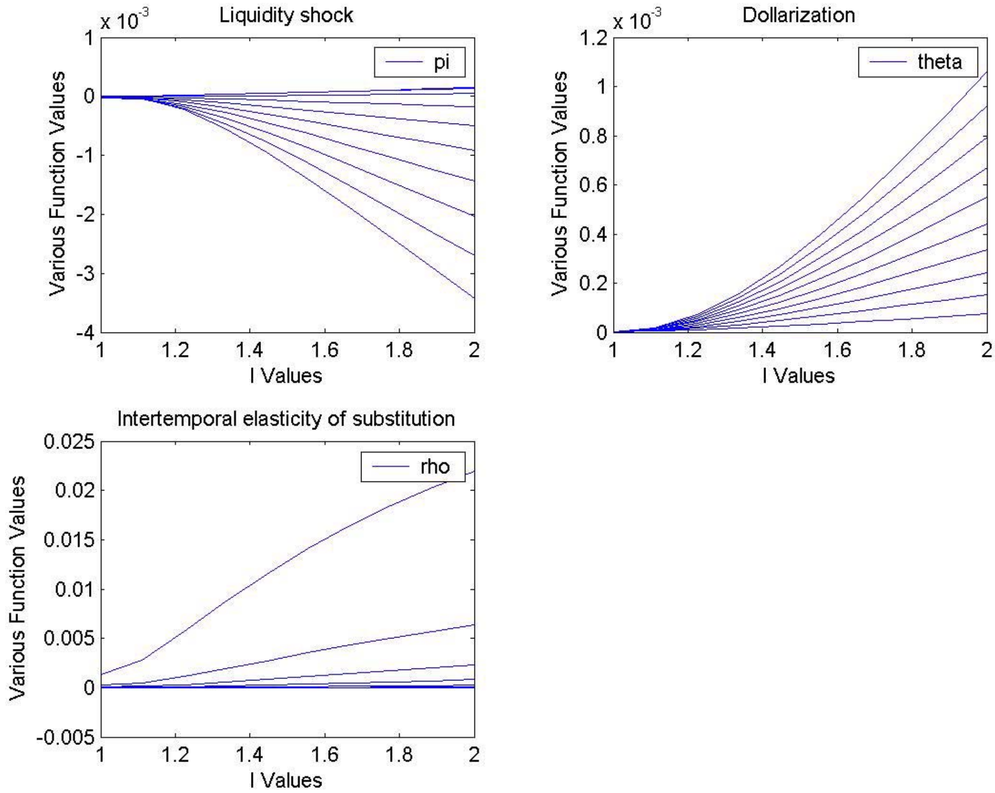


Figure 3 is very similar to figure 2, except where the coefficient of risk aversion ρ changes, growth can be an increasing function for low values of I, and a decreasing function for high values. This is the case when ρ is less than 0.2. We can also see the presence of the Mundell-Tobin effect, in particular when θ changes. In the other cases when θ is fixed, we can talk of a limited Mundell-Tobin effect since the economy reaches like a balanced growth path when the gross nominal interest rate is high.

Although the growth function is flat for different values of I when π changes, and not so flat when ρ changes, there is also a negative relation between the growth rate and these parameter values.

Let's define the growth-gap as the difference between the growth rate under competition and the growth rate under monopoly. Clearly if this gap is positive, it means that the growth rate under competition is bigger than the growth rate under monopoly ($\mu(I) > \widehat{\mu}(I)$). Figure 4 shows the output gap for different values of parameters.

Figure 4: Growth Gap



From the figure above, it can be seen that the growth rate under a competitive banking system (μ) will be higher than the growth rate under a monopolistic banking system ($\widehat{\mu}$), in almost all the cases that θ increases. For high values of ρ and particularly for π, this result changes and the growth rate under a monopolistic banking system will be higher than under a competitive banking system. Certainly the liquidity shock and the coefficient of relative risk aversion are key variables in explaining the growth gap between both types of economies, as Paal *et.al.*[20] shown. When agents demand a lot of insurance (π and ρ are high), then a monopolist can extract higher profits, and, as a result, capital investment and growth will be higher.

In this specific parameterization as π becomes higher, the growth rate under monopoly is very high compared with the growth rate under competition. With other parameterizations this result holds for different values of ρ and not for π.

5 Welfare under Alternative Banking Arrangements

In this section, I compare the depositor welfare under monopolistic versus competitive banking arrangements. There are two ways to do this: i) One way is to ask agents in one generation what monetary policy they would like the government to follow while they are alive; ii) another way is to ask what a benevolent social planner (or government) who takes into account the utility of future generations would do. Here I choose the second form where the government maximizes a weighted sum of the ex ante expected utility of depositors, with the weight β^t assigned to the utility of the generation born at t.

It is worth pointing out that holding the level of capital stock fixed at the beginning of the period, depositors would always prefer the competitive system, since competition generates the most consumer surplus. But this is not the end of the story because the behavior of the capital stock is endogenous to the model. If growth is higher under monopoly, then generations far in the future will prefer monopoly, even though they get a worse "deal" when they deposit their funds, because they will have much higher wages.

Based on this reasoning, if competition leads to a higher growth rate, it must be preferred by all generations. In the previous section, I have shown that competition must be preferred by all generations most of the time. However, in the cases where monopoly leads to a higher growth rate there is a tradeoff: the current generation (and maybe some others) prefers competition but generations far enough in the future prefer monopoly. Which one the social planner prefers will depend on the value chosen for β, which is the weight given to future generations.

The government objective functions, for competitive banking system and monopolistic banking system respectively are:

$$\Omega(I) = \sum_{t=0}^{\infty} \beta^t V(d_t^m, d_t^f, d_t^n, w_t) \tag{50}$$

and

$$\widehat{\Omega}(I) = \sum_{t=0}^{\infty} \beta^t V(\widehat{d}_t^m, \widehat{d}_t^f, \widehat{d}_t^n, w_t) \tag{51}$$

Using the same equations $A(I)$ and $B(I)$ of the proof of proposition 5, the two above equations can be written respectively as:

$$\Omega(I) = \frac{[(1-\alpha)Ak_0]^{1-\rho}}{1-\rho} \frac{(\psi^{\frac{1}{\rho}} + A(I))^{\rho}}{1-\beta\,[\mu(I)]^{1-\rho}} \tag{52}$$

$$\widehat{\Omega}(I) = \frac{[(1-\alpha)Ak_0]^{1-\rho}}{1-\rho} \frac{(\psi^{\frac{1}{\rho}} + B(I)^{\frac{1}{\rho}})^{\rho}}{1-\beta\,[\widehat{\mu}(I)]^{1-\rho}} \tag{53}$$

In order for the government's objective function to be well-defined, we must have $\beta\left[\mu(I)\right]^{1-\rho} < 1$. This condition places a lower bound on ρ given by:

$$\rho > 1 + \frac{\ln(\beta)}{\ln(\mu(I))} \tag{54}$$

An economy with a competitive banking system will be welfare improving if the following condition holds:

$$\frac{\left(\frac{A(I)}{\eta(I)}\right)^{\rho}}{1-\beta[\Psi(I)\eta(I)(1-\alpha)A]} > \frac{\left(\frac{B(I)^{\frac{1}{\rho}}}{\widehat{\eta}(I)}\right)^{\rho}}{1-\beta\left[\widehat{\Psi}(I)\widehat{\eta}(I)(1-\alpha)A\right]} \tag{55}$$

Inequality (55) does not say anything about the parameters, so I turn again to some numerical simulations, in order to establish some general results for the three main parameters of the economy. The following figure shows what I call the welfare-gap (WG), defined as $WG = \Omega(I) - \widehat{\Omega}(I)$. If this gap is positive, this means that a competitive banking system will be welfare enhancing.

Figure 5: Welfare Gap

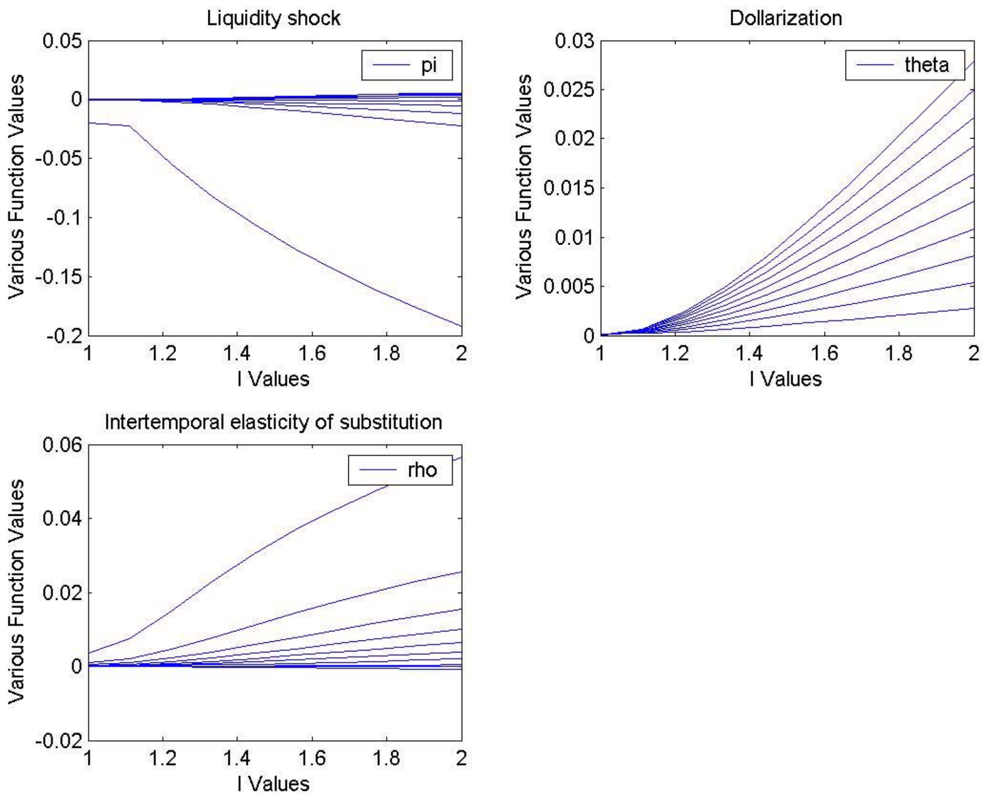


Figure 5 is very similar to figure 4 in the sense that the welfare-gap is positive in almost all cases, except when π and ρ are high. Welfare also depends on the value assigned to β. For different parameter values and combinations with β, welfare can be higher under a competitive banking system or under a monopolistic banking system. It is difficult to make general statements; calibrating the model to a randomly-selected economy, either result could obtain.

As stated above, working with simulations does not allow us to really conclude that what we have shown in the figures is exactly what could happen under the monopolistic case. By the other hand, what about magnitudes and what does high π and ρ mean? This questions could only be answered with a real case economy example.

6 Growth and Dollarization in the Bolivian Economy

In this section, I test the model in a real case economy to see if there are sizable differences between both types of structures. I also perform a sensitivity analysis, changing parameters one at a time. I chose Bolivia because it is a partially dollarized economy and it has a stable banking system that has been working with two monies, bolivianos (Bs.) and dollars (US$), for almost more than twenty years.[19]

Dollarization of the Bolivian economy and particularly of the banking system started in the middle of the 80´s, although the dollarization level of bank deposits started to grow faster by 1990. Between the years 1985-1990 the economy started a period of stabilization and still, there was no sufficient confidence in the banking system.[20]

The banking system in Bolivia can be considered as a competitive banking system. For a small economy like Bolivia, the fact that there are 12 banks is a sign of competition. Of these banks, four of them are foreign banks and the rest are domestic banks. The financial sector is not only composed by banks, there are other financial institutions like "Mutuales", "Cooperativas" and also Private Financial Funds. Here I consider only banks as they represent the main part of the financial sector and the model is built considering the banking system.

6.1 Calibration and Comparisons

Given that the Bolivian banking system is a competitive one, we can use the data and the equations derived for a competitive banking system, to infer all the parameters that are needed for the analysis. I calibrate the model using yearly data for the period 1995-2005. For this period, Bolivia had an average rate of inflation p_{t+1}/p_t of about 5.22 percent per year, with a real interest rate

[19] Other partially dollarized countries in Latin America are Perú, Uruguay, Mexico and Argentina.

[20] People lost confidence in the banking system during the hyperinflation episode, the first half of the 80´s (see Antelo [1] for a review).

R of 6.28 percent per year. This implies that a reasonable value for the nominal interest rate is 1.1183 percent per year.

The cost share of capital α is equal to 1/3. It is a standard value in the literature and states that wages represent about 70% of total cost.[21] The rest of the parameters have been calibrated to match the rate of investment of banks $\Psi(I_t)$, the savings rate of depositors $\eta(I_t)$, the growth rate of the economy $\mu(I_t)$ and the level of dollarization $\Phi(I_t)$. These are equations (30), (36), (40) and (23) respectively, to which we add equation (43) to form a non-linear system of equations.

Table 1: Calibrated Parameters

Parameter	Value	Description
ρ	0.74	Risk aversion coefficient
π	0.2272	Liquidity shock probability
θ	0.2067	Transactions demand in local money
α	1/3	Cost share of capital
σ	1.0883	Money growth rate
ψ	0.6909	Utility function parameter
A	3.1884	Technology shock

The risk aversion coeffcient ρ was set as in Paal, *et.al.*[20], Schreft and Smith [23] and Gomis and Smith [14] in which, similar type of models have been calibrated. The liquidity shock parameter π is a fixed probability of 23 percent and it represents the proportion of people that will demand liquidity in both monies. From this proportion 21 percent of people will demand local money and the rest (79 percent) will demand dollars. This is another way to represent that about three quarters of the deposits in the Bolivian banking system are in dollars and the rest in local currency. The rate of growth of money σ has been calibrated using equation (43) taking care in matching the inflation rate. The technology parameter A has been calculated using equation (5) which is an equilibrium condition for the firms and establishes a fixed value for the real interest rate R. Finally I set ψ equal to 0.7. Notice that this is a value calibrated to be smaller than one, meaning that in the last ten years, depositors actually valued their second period consumption more than their present consumption. This kind of saving behavior is typical in countries where the capital market is not well developed and banks have the essential role of allocating capital resources.[22]

Table 2: Target Values

Parameter	Value	Target	Description
$\Psi(I)$	0.7772	0.7772	Investment rate
$\eta(I)$	0.6261	0.626	Savings rate
$\mu(I)$	1.0343	1.0343	Growth rate
$\Phi(I)$	0.7962	0.7962	Level of dollarization

[21] Also used by Quiroz, *et.al.*[21] for the Bolivian economy.

[22] Paal, et.al.[20] states that this is also the case for Japan and uses a value for ψ equal to 0.6317.

The growth rate is taken from the National Accounts. The investment rate $\Psi(I)$ which is i/s corresponds to the part of banks' assets that are not in currency. So, it is not exactly the investment of the economy. I use a value calculated from the banks balance sheet which corresponds to the credit given by banks over total liabilities. The savings rate $\eta(I)$ is s/w. To calculate this ratio, one needs income wages of depositors and there is no data for this. So, I compute this ratio from $\mu(I) = \Psi(I)\eta(I)(1-\alpha)A$. The value of 0.62 perhaps is a little high and certainly biased because not all the deposits in the Bolivian banking system come from wage income. There are other incomes, like firms' profits or government payments that are also intermediated through banks. The level of dollarization is calculated from the banks assets and it represents the rest of the assets that are not given as credit. A big advantage of the Bolivian banking data is that it is separated in monies, so we have m and f and this ratio is simply $f/(m+f)$.[23]

In table 3, we can see that there are no differences between the competitive Bolivian banking system and a hypothetical monopolistic banking system. The reserve ratios and the rates have been calculated with the same parameter values and only up to a very accurate precision, we can see differences in both systems (fourth column). Notice that only the level of dollarization will be exactly the same under both systems as shown in section 2.4.

Table 3: Competitive vs Monopolistic Banking System

Variable	Competition	Monopoly	Differences
Reserve ratio in Bs.	γ =0.0454	$\widehat{\gamma}$ =0.0454	2.0359e-006
Reserve ratio in US$.	γ^* =0.1774	$\widehat{\gamma}^*$ =0.1774	7.9547e-006
Level of Dollarization	$\Phi(I)$ =0.7962	$\widehat{\Phi}(I)$ =0.7962	0
Investment rate	$\Psi(I)$ =0.7772	$\widehat{\Psi}(I)$ =0.7772	-9.9906e-006
Saving rate	$\eta(I)$ =0.6261	$\widehat{\eta}(I)$ =0.6261	3.6879e-006
Growth rate	$\mu(I)$ =1.0343	$\widehat{\mu}(I)$ =1.0343	-7.2031e-006

If we consider the differences between the two systems, the growth rate under monopoly is higher than the growth rate under competition in 7.2e-006. This result suggests that moving to a monopolized banking system in Bolivia, at current conditions, would increase the real growth rate, though not by a significant magnitude. This result is also in agreement with the findings of Paal *et.al*[20] for the U.S economy. They find that a competitive structure is better than a monopolistic structure in 2e-006 for the U.S. In any case this numbers are not significantly different.

Remember that $\mu(I) = \Psi(I)\eta(I)(1-\alpha)A$ (and the same for monopoly), so we can separate growth into two effects: An "investment allocation" effect that comes from $\Psi(I)$ and a "savings rate" effect that comes from $\eta(I)$. In this way, seeing that the growth rate under monopoly is "higher", means that the "investment allocation" effect is dominating the "savings rate" effect. Therefore,

[23] Orellana [19] calculated the level of dollarization in the transactions side and obtains a value of 0.86 for the year 1998.

reserve ratios in both monies will be higher in the competitive banking system, meaning that banks are investing less.

In summary, the main conclusion of this section is that the industrial organization of the banking system is not important for growth in the Bolivian economy.

6.2 Numerical Results for the Bolivian Economy

In this section I perform a parameter sensitivity analysis. I show how the rates of growth in both systems change as we change one parameter at a time. I begin by changing the money growth rate parameter σ, which governs the inflation rate p_{t+1}/p_t and also the gross nominal interest rate I (according to the Fisher equation). In Table 4, I present some simulations, beginning with the Friedman Rule ($I = 1$). We see that an optimal monetary policy is not good for growth since the economy only grows at 3.31 percent in both systems. Of course a deflation, in this case of -5.91 percent, is required to attain a gross nominal interest rate of 1. To generate this deflation, the government must be withdrawing 3 percent of the money remaining in circulation in each period.

Table 4: Growth under different Nominal Interest Rates

σValue	I Value	Inflation	Competition	Monopoly	Diff.
0.97205	1	-5.91%	1.0331	1.0331	-4.0494e-006
1	1.0285	-3.23%	1.0334	1.0334	-4.0842e-006
1.05	1.0794	1.56%	1.0339	1.0339	-5.3447e-006
1.1	1.1302	6.35%	1.0344	1.0344	-7.9071e-006
1.5	1.5368	44.6%	1.0374	1.0374	-5.4881e-005
2	2.044	92.33%	1.0399	1.04	-1.3612e-004

An optimal monetary policy or the Friedman Rule is not optimal for growth, because the Mundell-Tobin effect is present. We can observe that as there is more inflation in the economy, the real rate of growth is higher, but without considerable improvements. With a very high rate of inflation of 92.33 percent, the economy grows only at 0.56 percentage points more than our benchmark case. So, here it is clear that stabilization will be preferred than growth, since the economy gains almost nothing in terms of growth by turning on the money-printing-machine.

Then I perform simulations with the transactions demand for dollars $(1-\theta)$. In table 5, we see that growth is negatively related to this parameter. When there is full dollarization the economy grows at a rate of 3.37 percent and when there is no dollarization the economy can grow at 3.62 percent. So, we can say that it is good for growth to de-dollarize the economy.

Table 5: Growth and Transactions Demand in Dollars

$1-\theta$ Value	Competition	Monopoly	Diff.
1	1.0337	1.0337	-4.7790e-006
0.75	1.0344	1.0344	-7.6889e-006
0.5	1.035	1.035	-1.0352e-005
0.25	1.0356	1.0356	-1.2785e-005
0	1.0362	1.0362	-1.5005e-005

How important could be to de-dollarize the economy in terms of the real rate of growth? The results show that not very much, between full dollarization and no dollarization, the rate of growth improves only by 0.25 points. We can conclude that the level of dollarization of the banking system in Bolivia, is also not an important variable for growth.

Next, I simulate the economy for different values of π, to see the effects of a low or high probability of liquidity crises. Growth is negatively related with the liquidity demand and also very sensitive to it, as shown in table 6.

Table 6: Growth and Liquidity Demand

π Value	Competition	Monopoly	Diff.
0	1.3336	1.3336	4.4409e-016
0.1	1.2013	1.2013	3.5935e-007
0.25	1.0044	1.0044	-1.2114e-005
0.3	0.93907	0.9391	-3.3441e-005
0.5	0.67789	0.6785	-5.7481e-004
0.99	0.015	0.1022	-0.0872

Notice that when there is no liquidity demand, banks in either the competitive or monopolistic case invest all the deposits and the economy can reach an extremely high growth rate of 33 percent. If the liquidity demand increases to 25 percent, the economy does not grow, and with 26 percent the economy grows at a negative rate. Notice also that there is a threshold value of π around 11 percent. With a lower percentage the competitive banking system is better than the monopolistic banking system, while if π is higher than 11 percent the reverse holds and the monopoly is better.

Again we see that as people demand more insurance from banks (π is high) the monopoly behaves better in terms of growth. Although, the real rate of growth is negative for probabilities equal or higher than 30 percent, the rates of growth under the monopolistic banking system are less negative than under competition. The intuition is simple, as profits come from investment, banks will invest more, even if there is a high probability of liquidity demand. Observe that there are 8.7 percentage points of difference between both banking structures when all people demand liquidity (all people are movers).

In the theoretical section, we have seen that the coefficient of relative risk aversion ρ is also an important parameter as π for growth. The following table shows that this is also the case for the Bolivian economy. The real rate of growth is negatively related to ρ and also very sensitive.

Table 7: Growth and Risk Aversion

ρ Value	Competition	Monopoly	Diff.
0.1	1.4079	1.4163	-0.0085
0.25	1.3779	1.3772	6.8636e-004
0.5	1.1424	1.1424	5.0027e-006
0.75	1.0311	1.0311	-7.0156e-006
0.99	0.9733	0.9733	-2.4229e-008

In this case, the monopolistic banking system is better in terms of growth not only with high values of ρ, but also for small values of this parameter. In fact, when $\rho\epsilon(0.166, 0.537)$ the growth rate under a competitive banking system is higher than the growth rate under a monopolistic banking system. With low values of ρ, the growth rate under both systems is extremely high. The intuition for this result is: When ρ is far away from 1, the substitution effect of an increase in the gross nominal interest rate I is stronger than the income effect (in fact the substitution effect dominates when $\rho < 1$). The substitution effect says that consumption when old is now relatively less expensive, so young depositors increase their savings and since the liquidity demand π is fixed, these savings are destined mainly to investment, so investment is high and the rate of growth is high also. As ρ increases, young agents save less and so competitive banks or the monopolistic bank invest less.

The main conclusion that can be taken from this section is that there are two main parameters that affect growth in the Bolivian economy and, as stated in the theoretical section, in any partially dollarized economy. These are the coefficient of risk aversion of Arrow-Pratt ρ and the probability of liquidity shocks π. They are negatively related to growth and growth is very sensitive to them. As π or ρ increase, the growth rate decreases and also negative rates of growth can be experienced. In most cases, the differences between competition and monopoly are negligible. So, I can say again that the industrial organization of the banking system is not important in a partially dollarized economy like the Bolivian one.

6.3 Welfare in the Bolivian Economy

In this section, I just want to compare the welfare functions under the actual competitive system and the hypothetical monopolistic system. The following table shows the welfare values for the real parameters under both systems and some simulations for different values of the nominal interest rate. I assume an initial value for k, $k_0 = 1$ and $\beta = 1/R$. This condition gives us a value for β equal to 0.94.

Table 8: Welfare in the Bolivian Economy

I Value	Competition	Monopoly	Welfare Gap
1.1183	131.7513	131.7548	-0.0035
1	131.1375	131.1394	-0.002
1.2	132.1302	132.1366	-0.0064
1.5	133.2869	133.3113	-0.0244
2	134.6861	134.7506	-0.0645

In table 8, it can be seen that welfare is higher under monopoly and the welfare gap increases as the gross nominal interest rate increases. I want to stress that these results depend primarily on β. Growth could be higher under the monopoly system, but still yield lower welfare. This is the case if β is lower than 0.8.

7 Conclusion

In this paper I have constructed a general equilibrium model with an active banking sector to analyze dollarization and growth for two different structures of the banking system, a competitive banking system and a monopolistic banking system. The theoretical model showed that banks will hold reserves in local and foreign money to be able to serve those people that will move early to another location (island). But another part of deposits will be invested in capital and this will promote growth in the economy.

Under this framework, a general intuition is that a monopolistic banking system will invest more and because of this the economy will have a higher rate of growth. The model shows that this is not always true. When analyzing the two types of structures, there are two effects that have to be considered: a "savings rate" effect and an "investments allocation" effect. If the first effect dominates, it is possible that an economy with a competitive banking system grows more. The question of which effect dominates depends on the combination of the three main parameters of this economy which are: the risk aversion coefficient ρ, the liquidity shock probability π and the transactions demand parameter θ. In particular the first two are very important to explain growth since the growth rate is very sensitive to changes in these parameters.

In the model, I assumed that all of the monopolist's profits are invested. Even with this extreme assumption, it is shown that competition is almost always better. Only, for high values of the liquidity shock π and the risk aversion coefficient ρ, the monopolistic banking system can promote more growth than the competitive banking system. A high value of these parameters means that there is a high demand of liquidity insurance. A 'high' demand of liquidity insurance is country specific.

Another conclusion that arises is the existence of a Mundell Tobin effect; this means that the growth rate is positively related to inflation. When the nominal interest rate goes up, banks will hold less money and therefore will place more resources into investment, leading to more growth in the economy.

People are very accustomed to thinking that competition is good and monopoly is bad. In fact, from the theoretical section it seems that a competitive banking system is "better" than a monopolistic system in almost all situations. How much better or how big the differences between the two systems can be is a question answered with the help of a real example economy. I analyze Bolivia, which is a partially dollarized economy and show that all the theoretical results hold. But, I conclude that for Bolivia, the industrial organization of the banking system does not matter for growth.

This is a surprising result. Working with accurate precision, it can be seen that the growth rate under monopoly is "higher" than the growth rate under competition. In a narrow sense, I can conclude that in the Bolivian case, the "investment allocation" effect dominates the "savings rate" effect.

Changing some of the parameter values, it is seen that the rate of growth is very sensitive to the coefficient of relative risk aversion and the probability of liquidity crises. The liquidity demand in Bolivia is 22.72 percent. If for some reason this probability decreases to 20 percent, the real growth rate will double. Of course, when there is a high liquidity demand, growth rates are negative. Here, depositors will demand a lot of insurance from banks and they will invest less, though the monopolistic bank will always invest a little more than the competitive banks since its profits come from investments.

The transactions demand in dollars does not affect growth in a significant way. Moving from full dollarization to non-dollarization, in terms of transactions, changes the growth rate by a range of 0.25 percentage points only. Even more, the level of dollarization is the same under both systems, so the industrial organization is not a determinant of dollarization.

Finally, a welfare measure for Bolivia has been computed and it is shown that in terms of welfare the monopolistic banking system is slightly superior than the competitive banking system. This result tells us that people in Bolivia prefer growth than risk-sharing.

The model developed here can be improved in two ways. First it would be interesting to see how the results could change if we assume that the probability of liquidity demand is a random variable instead of a fixed number. Second, the outside option for the monopoly can also be changed assuming autarky instead of a capital resale market. This would add to the model the possibility to scrap investments.

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